460

STATE OF ILLINOIS

DEPARTMENT OF REGISTRATION AND EDUCATION

SUMMARY OF THE GEOLOGY OF THE CHICAGO AREA

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ILLINOIS STATE GEOLOGICAL SURVEY

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Time Stratig. System	Series	Stage	Rock Stratigraphy Megagroup	Group	Formation	Graphic Column	Thickness (Feet)	Kinds of Rock	
QUAT.	PLEIS.				(See fig 15)		0-350	Till, sand, gravel, silt, clay, peat, marl, loess	
PENN.	DESM.			Kewanee	Carbondale		0-125	Shale, sandstone, thin limestone, coal	Not present in area.
					Spoon		50-75	As above, but below No 2 Coal	
MISS	VAL.				Burl-Keokuk		0-700	Limestone — Only in Des Plaines Disturbance	
	KIND.				Hannibal			Shale, siltstone — Only in Des Plaines Disturbance	
DEV	UP.				Grassy Creek		0-5	Shale in solution cavities in Silurian	
SILURIAN	NIAGARAN		Hunton		Racine		0-300	Dolomite, pure in reefs, mostly silty, argillaceous, cherty between reefs	
					Waukesha		0-30	Dolomite, even bedded, slightly silty	
					Joliet		40-60	Dolomite, shaly and red at base, white, silty, cherty above, pure at top	
	ALEX				Kankakee		20-45	Dolomite, thin beds; green shale partings	
					Edgewood		0-100	Dolomite, cherty, shaly at base where thick	
ORDOVICIAN	CIN.	RICH		Maquoketa	Neda		0-15	Oolite and shale, red	Confining Layer
					Brainard		0-100	Shale, dolomitic, greenish gray	
					Ft Atkinson		5-50	Dolomite, green shale, coarse limestone	
		MAY / ED			Scales		90-120	Shale, dolomitic, gray, brown, black	
	CHAMPLAINIAN	TRENT	Ottawa	Galena	Wise Lake		170-210	Dolomite, buff, pure	
					Dunleith			Dolomite, pure to slightly shaly; locally limestone	
					Guttenberg		0-15	Dolomite, red specks and shale partings	
		BLACKRIVERAN		Platteville	Nachusa		0-50	Dolomite and limestone, pure, massive	
					Grand Detour		20-40	Dolomite and limestone, medium beds	
					Mifflin		20-50	Dolomite and limestone, shaly, thin beds	
					Pecatonica		20-50	Dolomite, pure, thick beds	
				Ancell	Glenwood		0-80	Sandstone and dolomite, silty, green shale	
					St Peter		100-600	Sandstone, medium and fine grained; well rounded grains, chert rubble at base	
	CANADIAN		Knox	Prairie du Chien	Shakopee		0-70	Dolomite, sandy; oolitic chert; algal mounds	
					New Richmond		0-35	Sandstone, fine to coarse	
					Oneota		190-250	Dolomite, pure, coarse grained, oolitic chert	
					Gunter		0-15	Sandstone, dolomitic	
CAMBRIAN	CROIXAN	TREMP.			Eminence		50-150	Dolomite, sandy	
					Potosi		90-220	Dolomite; drusy quartz in vugs	
		FRAN.			Franconia		50-200	Sandstone, glauconitic; dolomite, shale	
					Ironton		80-130	Sandstone, partly dolomitic, medium grained	
		DRESBACHIAN			Galesville		10-100	Sandstone, fine grained	
					Eau Claire		370-570	Siltstone, dolomite, sandstone and shale, glauconitic	Confining Layer
			Potsdam		Mt. Simon		1200-2900	Sandstone, fine to coarse; quartz pebbles in some beds	
PRE-CAM.								Granite	

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CAMBRIAN SYSTEM

The rocks of the Cambrian System are marine in origin and were deposited in a sea that covered all of Illinois. The lower half is largely sandstone, and the upper half is dolomite, sandy dolomite, sandstone, and siltstone. The sandstones are near-shore deposits composed of sand transported to the sea by rivers flowing from northern highlands. They generally grade southward into deeper water sediments, largely dolomite. The transition zone is north of the Chicago area in some formations, south of it in others. As a result, the Cambrian formations are dominantly sandstone in Wisconsin and dominantly dolomite in southern Illinois, and both rock types are present in the Chicago area (fig. 5).

Cambrian rocks are deeply buried in the Chicago area, but they occur directly below the glacial drift only 10 miles west of the area and the uppermost beds are exposed near Oregon, 40 miles west. They include 3,000 to 4,000 feet of deposits, nearly twice the thickness of all the younger strata in the area. The lower sandstone strata (Mt. Simon and lower Eau Claire) are part of the Potsdam Megagroup (Swann and Willman, 1961). They are separated by a zone of varied lithology (Eau Claire to Franconia) from the upper dolomite formations (Potosi and Eminence), which are similar to overlying lower Ordovician beds and are included with them in the Knox Megagroup. The Cambrian rocks in the Chicago area are all late Cambrian in age and are assigned to the Croixan Series. Detailed descriptions of the formations and their subdivision into members were given by Buschbach (1964).

Mt. Simon Sandstone - The Mt. Simon Sandstone consists of fine- to coarse-grained, poorly sorted sandstone interbedded with sandstone containing small quartz pebbles that serve to divide the formation into members (Templeton, 1950). Red and green micaceous shales are a minor constituent. The elevation of the top of the sandstone in part of the area was shown by Suter et al. (1959, fig. 19). The Mt. Simon Sandstone is as much as 2,900 feet thick in the southern part of the area, but it thins to 1,200 feet at the Wisconsin-Illinois state line (Buschbach, 1964, fig. 10). The sandstone is an important source of water (Suter et al., 1959), and in the Herscher Dome, immediately south of the area, it and higher sandstones are used for the storage of natural gas (Buschbach and Bond, 1967).

Eau Claire Formation - The Eau Claire Formation is largely sandstone in the northern part of the area, but siltstone, shale, and dolomite increase in abundance southward. The formation is subdivided into a sandstone member at the base, a glauconitic dolomite member in the middle, and a siltstone and shale member at the top. It is 370 to 450 feet thick in the central and northern parts of the area, but it thickens to 570 feet in the southern part (Buschbach, 1964, fig. 11). The elevation of the top is between 750 and 1,500 feet below sea level (Suter et al., 1959, fig. 19). A "sooty" zone at the base consists of sandstone with a black coating of fine-grained pyrite on the sand grains.

Galesville Sandstone - The Galesville Sandstone is white, fine-grained, well sorted sandstone 10 to 100 feet thick (Buschbach, 1964; Emrich, 1966). It consists largely of well rounded quartz grains. Because of its high permeability it is an important aquifer (Suter et al., 1959).

Ironton Sandstone - The Ironton Sandstone varies more than the Galesville. It is medium grained, not as well sorted, and is in part dolomitic. It is 80 to 130 feet thick. The elevation of the top was shown by Buschbach (1964, pl. 10).

Franconia Formation - The Franconia Formation consists of gray to pink, argillaceous, silty, glauconitic sandstone and dolomite. It contains some interbedded red and green shale. It is 50 to 200 feet thick (Buschbach, 1964, pl. 3).

Potosi Dolomite - The Potosi Dolomite, called Trempealeau in many earlier reports, consists of fine-grained, gray to brown dolomite that is relatively pure, except for small crystals of quartz that coat the surface of cavities. It thickens from 90 feet in the northern part to 220 feet in the southern (Buschbach, 1964, pl. 4). Local areas of thinning result from pre-St. Peter erosion.

Eminence Formation - The Eminence Formation consists of light colored sandy dolomite. A thin bed of sandstone at the base generally separates it from the nonsandy Potosi Dolomite. The dolomite contains oolitic chert and thin beds of sandstone. It is generally absent in the northern part of the region because of pre-St. Peter erosion. In the area where it is overlain by the Oneota Dolomite, it thickens southward from 50 to 150 feet.

ORDOVICIAN SYSTEM

The Ordovician rocks, like the Cambrian, are all marine sediments and were deposited in a shallow sea that covered much of the interior part of the continent. They are subdivided into three series, all of which occur in the Chicago area (fig. 5). The lower, the Canadian Series, is largely dolomite but contains some sandstone; the middle, the Champlainian Series, is largely dolomite and limestone and has a prominent sandstone at the base; and the upper, the Cincinnatian Series, is largely shale and contains some limestone. The Canadian and lower Champlainian rocks do not crop out in the area, but they have been penetrated in many wells and are exposed along the Fox River only 3 miles west of the Chicago area in the Sandwich (15-minute) Quadrangle (Willman and Payne, 1943). The younger Ordovician rocks are exposed in the southwestern part of the area, particularly along the lower parts of the Kankakee, Des Plaines, and Du Page Rivers. The Ordovician strata range from 700 to 1,100 feet thick. They have been described in detail by Buschbach (1964).

Canadian Series

The lower Ordovician Canadian Series is largely dolomite but has sandstones at the base and near the top. The four formations in the series are combined as the Prairie du Chien Group. They are also part of the Knox Megagroup, which includes similar dolomite at the top of the Cambrian. In the northern third of the Chicago area, the Canadian Series was entirely eroded before the St. Peter Sandstone was deposited, but south of there the series thickens southward, reaching 300 feet near the southern boundary of the area.

Gunter Sandstone - The Gunter Sandstone consists of lenses of medium-grained sandstone present in places at the base of the Ordovician System. It contains a little dolomite and green shale and generally is less than 15 feet thick.

Oneota Dolomite - The Oneota Dolomite is largely coarse-grained dolomite 190 to 250 feet thick. The lower half is cherty, whereas the upper half is relatively pure. Oolitic chert nodules are common.

New Richmond Sandstone - The New Richmond Sandstone is fine- to coarse-grained quartz sandstone. It is dolomitic in places and locally contains oolitic and sandy chert at the top. It is not as well sorted as the St. Peter Sandstone and is more cross bedded. It has a maximum thickness of about 35 feet in the Chicago area.

Shakopee Dolomite - The Shakopee Dolomite consists of thin- to medium-bedded, fine-grained dolomite. Some beds are argillaceous and others are sandy. It contains thin beds of sandstone and green shale and lenticular masses of laminated dolomite that are algal reefs. The formation is as much as 70 feet thick. Its top is marked by the prominent sub-St. Peter unconformity.

Champlainian Series

The Champlainian Series consists of three groups of rocks (Templeton and Willman, 1963). The Ancell Group at the base is dominantly sandstone that unconformably overlaps older Ordovician and Cambrian formations. The Platteville Group above consists of slightly shaly and relatively pure limestone and dolomite formations. The Platteville is separated by minor unconformities from the groups above and below. The Galena Group at the top also is dominantly dolomite and limestone, and it contains distinctive red shale partings at the base. Because both are dominantly limestone and dolomite, the two groups are combined in the Ottawa Megagroup.

The oldest rocks well exposed in the Chicago area are in the Galena Group in a quarry at Central, north of Morris. However, a few shallow exposures farther west near Lisbon may be in the older Platteville Group. In a small area near Lisbon the Ancell Group (St. Peter Sandstone) lies directly beneath the glacial drift, and it is the oldest unit on the geologic map of the bedrock surface (fig. 9). The Champlainian Series ranges from 400 to 1,000 feet thick, but it commonly is 500 to 600 feet thick.

Ancell Group

St. Peter Sandstone - The St. Peter Sandstone is white, fine- and medium-grained, well sorted sandstone composed almost entirely of well rounded and frosted grains of quartz. At its base, a distinctive rubble of angular chert embedded in clay is the residue left from solution of the underlying formations. It is widely present, uneven in thickness, and locally as much as 100 feet thick where the formation is thick. Red and green shale also occurs at the base. The formation is commonly 100 to 200 feet thick, but where it fills valleys and sinkholes it is as much as 600 feet thick (Buschbach, 1964, pl. 6).

Glenwood Formation - The Glenwood Formation consists of sandstone, impure dolomite, and shale and is as much as 80 feet thick. In many localities it consists of only a few feet of sandstone, generally coarser grained and more poorly sorted than the St. Peter Sandstone below. The elevation of the top is shown in figure 12.

Platteville Group

Pecatonica Dolomite - The Pecatonica Dolomite consists of brown, relatively pure dolomite. It generally is sandy at the base and is separated by a minor unconformity from the Glenwood below. Locally it grades to pure, very fine-grained limestone. It is 20 to 50 feet thick.

Mifflin Formation - The Mifflin Formation consists of light gray, very fine-grained, thin-bedded limestone or dolomite that contains green or brown shale partings. It is 20 to 50 feet thick.

Grand Detour Formation - The Grand Detour Formation is also fine-grained limestone and dolomite, but it is light brownish gray, has dark gray mottling, is medium-bedded, and has thin red shale partings at the top. It is 20 to 40 feet thick.

Nachusa Formation - The Nachusa Formation consists of relatively pure, medium-grained, brown dolomite or limestone. It is similar to the limestone and dolomite in the overlying Galena Group and not readily separable from it where the basal Galena Guttenberg Formation with its distinctive red shale partings is absent. The Nachusa Formation has a maximum thickness of 50 feet, but it is absent in places. A minor unconformity at the top results in irregular thicknesses and accounts for the absence of the Quimbys Mill Formation, which overlies the Nachusa a short distance west of the Chicago area.

Galena Group

Guttenberg Formation - The Guttenberg Formation consists of brown dolomite, or limestone in places, distinguished by the presence of red speckling or thin, reddish brown shale partings. It locally contains a trace of fine quartz sand. It is as much as 15 feet thick but is absent in places.

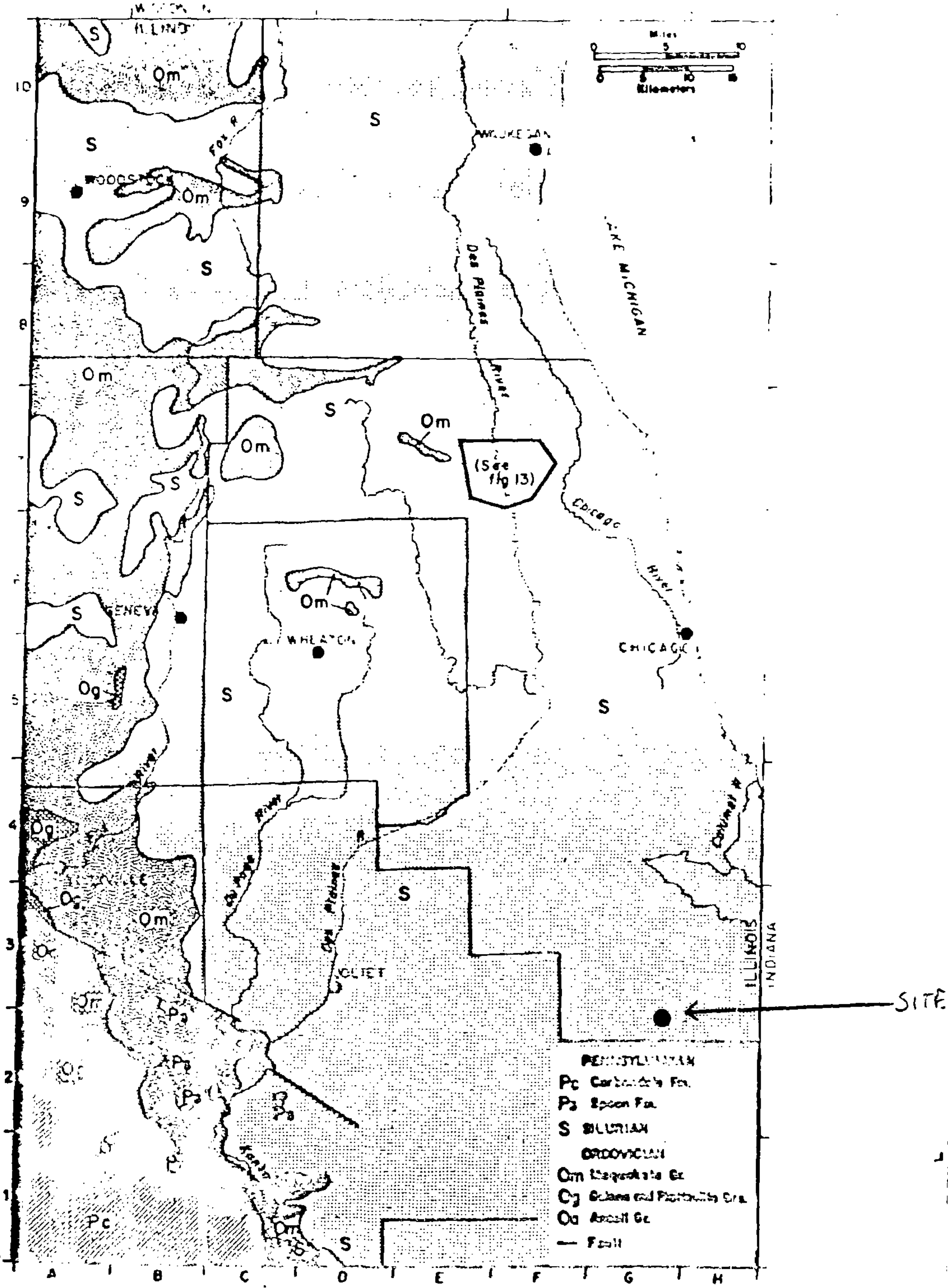

Fig. 9 - Geologic map of the bedrock surface (after Willman and others, 1967).

Dunleith and Wise Lake Formations - The Dunleith and Wise Lake Formations together consist of 170 to 210 feet of brown, pure, fine- to medium-grained dolomite, except in the southwestern part of the area where they are largely fine-grained limestone mottled with dolomite. West of the Chicago area, the Dunleith Formation is thin- to medium-bedded, light brownish gray, slightly argillaceous, cherty dolomite, whereas the Wise Lake is massive, vuggy, brown, pure dolomite. As the Dunleith becomes more pure and noncherty eastward, the two formations become similar, and they are not easily distinguished in the Chicago area.

The Wise Lake and Dunleith Formations crop out only in the southwestern part of the Chicago area (pl. 1), on the upthrown (south) side of the Sandwich Fault (fig. 12). About 80 feet of limestone is exposed in the quarry at Central in the Lisbon Quadrangle, 7 miles north of Morris (fig. 10B). This quarry appears to be largely in the Wise Lake Formation but the lower part may include part of the Dunleith Formation. The limestone in the quarry is mottled with dolomite which is recognized by its coarser grain size and darker color. Fossils are common in some beds (figs. 7 and 8). The Wise Lake Dolomite exposed along the Fox River at Millhurst, 2 miles west of the area, contains the distinctive sponge *Receptaculites* (fig. 7), the large gastropod *Hormotoma* (fig. 7), and other fossils.

Cincinnatian Series

The upper Ordovician Cincinnatian Series consists dominantly of gray and green shale, but it includes brown, red, and black shale. It has a persistent limestone formation in the middle and hematite oolites at the top. The shales are consolidated deposits of clay and silt carried into the interior sea when rivers from highlands along the eastern margin of the continent built large deltas in the Appalachian region. A minor unconformity occurs at the base of the series, and the sub-Silurian unconformity, which has valleys as much as 100 feet deep, occurs at the top. Because the sub-Silurian unconformity was produced by nearly vertical uplift, the strata above and below the unconformity are essentially parallel. All the Cincinnatian rocks in the Chicago area belong to the Maquoketa Group. They are exposed only in the southwestern part of the Chicago area (pl. 1), but they directly underlie the glacial drift at many places in the western part of the area (fig. 9).

Maquoketa Group

Scales Shale - The Scales Shale is largely gray shale, but the lower part is locally dark brown to nearly black in the southern part of the area. Much of the shale is dolomitic. Thin beds with small black phosphatic nodules and small pyritic fossils, called "depauperate beds," occur near the base and locally near the top. The trilobite *Isotelus* (fig. 7) is common in the shale between the upper depauperate bed and the overlying Fort Atkinson Limestone. The lower depauperate bed is not exposed in the area but is commonly encountered in drill holes. The upper bed and the *Isotelus*-bearing shale were formerly exposed in the H. I Green Company clay pit at Goose Lake, 4 miles north of Coal City (Coal City Quad.). The Scales Shale is 90 to 120 feet thick. There are few outcrops, and these expose only a few feet of the shale.

Fort Atkinson Limestone - The Fort Atkinson Limestone varies in composition. It consists of gray, fossiliferous, shaly limestone in outcrops along the Kankakee River near Wilmington (Wilmington Quad.); tan and pink, crinoidal, coarsely crystalline limestone (fig. 10C) overlying fine-grained dolomite near the Dresden Island lock and dam (Minooka Quad.) and north of Millsdale (Channahon Quad.); and mostly fine-grained dolomite interbedded with shale elsewhere. It is exposed only along the Kankakee River and the lower parts of the Des Plaines and Du Page Rivers. The formation is 20 to 30 feet thick in the outcrop area, but in drill holes elsewhere it ranges from 5 to 50 feet thick. The limestone contains a variety of fossils, with the brachiopod *Rafinesquina* (fig. 8) particularly abundant.

Brainard Shale - The Brainard Shale consists of greenish gray shale that is generally dolomitic and in places grades into silty argillaceous dolomite. It has a maximum thickness of 100 feet, but in some localities it is entirely truncated by the sub-Silurian unconformity. The Brainard is exposed on the east side of the Des Plaines Valley along the Atchison, Topeka, and Santa Fe Railroad 2 miles north of Millsdale and along the Du Page River and Rock Run 2 miles north of Channahon (Channahon Quad.).

Neda Formation - The Neda Formation consists of beds of hematite oolites interbedded with red and gray shale. It is present only where the Brainard Shale is thick, and in many parts of the area it was eroded away along the sub-Silurian unconformity (Workman, 1950). The formation has a maximum thickness of 15 feet. It is exposed along the Kankakee River in the Kankakee River State Park campground about 2 miles south of the Chicago area.

SILURIAN SYSTEM

The Silurian System, like the Ordovician, consists of deposits in the shallow interior sea. The strata are almost entirely dolomite that varies from extremely argillaceous, silty, and cherty to exceptionally pure. The lower part of the system consists of distinctive units that have lateral continuity throughout the region. The upper part is characterized by reefs of pure dolomite surrounded by well bedded, slightly argillaceous to very impure and generally cherty dolomite.

The entire Silurian System in the Chicago area was called Niagaran dolomite in early reports, but it now is differentiated into two series — the Alexandrian Series below and the Niagaran Series above (fig. 5). They are separated by a minor interruption in sedimentation. The upper Silurian Cayugan Series is not present in the area. The Silurian rocks are part of the Hunton Megagroup that farther south includes Devonian limestone and dolomite. Silurian strata crop out at many places in the southern half of the Chicago area (pl. 1). They were described by Fisher (1925); Savage (1926); Bretz (1939); Willman (1943, 1962); Lowenstam (1948, 1949); and others.

The Silurian System has a maximum thickness of nearly 500 feet in the southeastern part of the region (Suter et al., 1959, fig. 27). The top is eroded, but it is not far below the overlapping Devonian sediments that occur a short distance east in Indiana. Because of the eastward dip of the formations, the present bedrock surface successively truncates the Silurian formations from Lake Michigan westward to the margin of the Silurian rocks in the western part of the area. Much of this truncation was probably accomplished during the formation of the sub-Middle Devonian unconformity, because the Silurian strata are only 230 feet or less thick in the Des Plaines Disturbance (fig. 13) where they are overlain by shale of Upper Devonian-Mississippian age.

The Silurian rocks are generally fossiliferous, those in the reefs abundantly so (figs. 7 and 8). However, the fossils are preserved only as casts and molds. The original calcite and aragonite shells have been largely destroyed during recrystallization to dolomite.

Alexandrian Series

The Alexandrian strata filled the deep channels eroded in the underlying Maquoketa Group and overtopped the divides between the channels. Alexandrian strata vary from only 20 feet thick along the Kankakee River to as much as 150 feet in the deeper channels in the sub-Silurian surface.

Edgewood Dolomite - The Edgewood Dolomite changes progressively from highly argillaceous, dark gray dolomite in the lower part of the channels in the sub-Silurian surface to only slightly argillaceous, light brownish gray dolomite in the upper 25 feet. The upper zone is characterized by white chert in beds, lenses, and nodules. The formation has a maximum thickness of 100 feet. Where it thins over the divides between the channels, only the upper zone is present, and along the Kankakee River the formation is absent locally. The basal part of the thick Edgewood is well exposed along the Atchison, Topeka, and Santa Fe Railroad at the curve 5 miles southwest of Joliet (fig. 10D), and the eastward dip of the beds brings the upper cherty beds to the level of the railroad about a mile northeast of the curve (Channahon Quad.).

Kankakee Dolomite - The Kankakee Dolomite consists of fine- to medium-grained, gray to pinkish gray dolomite in wavy beds 1 to 3 inches thick that are separated by thin partings of green shale (fig. 11C). Chert nodules are locally present but are not abundant. The formation is 40 to 50 feet thick in much of the area, but between Joliet and the Kankakee River southeast of Wilmington it thins to 20 feet.

The Kankakee Dolomite is well exposed in its type locality along the Kankakee River, just south of the area (Herscher 15-minute Quad.); in the Des Plaines Valley bluffs and quarries on the southwest side of Joliet (Channahon, Elwood and Joliet Quads.); in deep quarries at Elmhurst (Elmhurst Quad.), Hillside (Hinsdale Quad.), and the Stearns quarry at 26th Street and Archer Avenue in Chicago (Englewood Quad.); and along the Fox Valley southwest of South Elgin (Geneva Quad.) and east of Oswego (Aurora South Quad.).

The lower few feet of the Kankakee is more massive and contains abundant corals, scattered quartz sand grains, and small, bright green grains of glauconite. The fossil brachiopod *Platymerella manniensis* (fig. 8) is abundant in white chert nodules at or near the base in nearly all exposures.

The uppermost bed of the Kankakee Dolomite is a distinctive white, pure, massive dolomite about 2 feet thick that is an important key bed in the Silurian section. It contains the large brachiopod *Pentamerus oblongus* (fig. 8), commonly in closely packed clusters. A similar shell called *Microcardinalia pyriformis* (fig. 8) is regionally persistent in this bed and is a guide fossil to the top of the Alexandrian Series. The top of the bed has a distinctive surface that is smooth and flat in comparison with other bedding planes. However, the smooth surface has sharp pits one-fourth to one-half inch wide and equally deep, most of them filled with green clay. The pits are more or less regularly distributed, roughly 10 to 15 to a square foot. This bed is recognized throughout the area, and because it varies only a few inches in thickness, the smooth surface on top can hardly be an erosional surface. It appears more likely to be a solution surface, also called a corrosion surface, formed by a change in the sea water that favored solution rather than deposition. The pits may have been made by stems or roots of plants attached to the sea floor.

Fig. 10 - Exposures of Ordovician, Silurian, and Pennsylvanian formations

A - Carbondale Formation (Pennsylvanian) overlain by glacial till of the Wedron Formation (the smooth surface at top) along Waupecan Creek, 2½ miles southwest of Morris (Morris Quad.). The cross-bedded Vermilionville Sandstone Member at the top of the Carbondale overlies 12 feet of Canton Shale (smooth surface). A ledge of black slaty shale lies at the base of the Canton Shale and below it is a prominent ledge of the Covel Conglomerate with associated limestone lenses.

B - Limestone of the Galena Group (Ordovician) in quarry at Central, 7 miles north of Morris (Lisbon Quad.). The quarry face is about 50 feet high.

C - Fort Atkinson Limestone (Ordovician) along the Elgin, Joliet, and Eastern Railroad at Divine, 1 mile southwest of Dresden Island Lock and Dam (Minooka Quad.). The limestone is crinoidal and pink and the beds are lenticular.

D - Edgewood Dolomite (Silurian) filling channel 4 feet deep in Maquoketa Group shale (Ordovician) along the Atchison, Topeka, and Santa Fe Railroad south of curve, 5 miles southwest of Joliet (Channahon Quad.).

E - Racine Dolomite (Silurian) showing massive dolomite of reef core exposed in Material Service Corporation Stearns quarry, 26th Street and Archer Avenue, Chicago (Englewood Quad.).

F - Racine Dolomite (Silurian) showing well bedded, dipping, reef-flank beds in Material Service Corporation quarry at Thornton (Calumet City Quad.).

Niagaran Series

Joliet Dolomite - The Joliet Dolomite is 40 to 60 feet thick and has three distinctive units. The basal unit, 5 to 20 feet thick, is shaly and is characterized by interbedded red coarse-grained dolomite and greenish gray, fine-grained, argillaceous dolomite. The beds are separated by red and green shale partings. Near the middle of the basal unit a bed of green shale as much as 3 feet thick is present locally. The middle unit, 20 to 30 feet thick, consists of medium-bedded, light gray, nearly white, fine-grained, cherty dolomite that is very silty at the base but grades to only slightly silty at the top. The upper unit, 20 to 25 feet thick, is nearly white, locally mottled pink, vuggy, pure dolomite. It is thin bedded but the bedding is faint. The lower part contains a few beds of white chert (fig. 11D).

The type section of the Joliet Dolomite is in the National Stone Company (Vulcan Materials) quarry at Joliet (Joliet Quad.) (fig. 11D). The formation is well exposed in other quarries at Joliet, in the south bluffs of the Des Plaines Valley west of Joliet (Elwood Quad.), along the Du Page River at Naperville (Naperville and Normantown Quads.), along the Fox Valley at Batavia and Aurora (Aurora North Quad.), and in the same deep quarries as the Kankakee Dolomite.

Waukesha Dolomite - The Waukesha Dolomite was called the "Athens marble" when it was quarried extensively for building stone used in constructing many buildings in Chicago and throughout the region. It is a slightly silty, dense to finely vuggy, fine-grained dolomite that occurs in smooth-surfaced beds that commonly are 2 to 8 inches thick but are locally as much as 3 feet thick. It is light brownish gray and weathers brown. It is exposed at the top of the National Stone Company quarry at Joliet (fig. 11D), in the Des Plaines River bluffs from Joliet northward to Romeo and eastward to Sag Bridge (Joliet, Romeoville, and Sag Bridge Quads.), and in the deep quarries at Elmhurst and Hillside. The formation is 20 to 30 feet thick in the outcrop areas, but it is locally missing in the subsurface in the eastern part of the region.

Racine Dolomite - The Racine Dolomite is as much as 300 feet thick along the eastern edge of the region, but it thins westward because of truncation by the present bedrock surface. The lowest beds are exposed at the top of the Des Plaines Valley bluffs from Joliet to Sag Bridge. The lower and middle parts are exposed in the quarries at Hillside (Hinsdale Quad.) and Elmhurst (Elmhurst Quad.). The quarries at Hodgkins, McCook, and LaGrange (Berwyn Quad.) are in the middle part. The upper part is exposed in the Stearns quarry in Chicago (Englewood Quad.), in the Thornton quarry (Calumet City Quad.), and in small exposures at Stony Island (Lake Calumet Quad.) and Chicago Heights (Calumet City Quad.).

The Racine Dolomite is characterized by the presence of large reefs, some of which grew to heights of 100 feet or more above the surrounding sea floor. Some reefs are nearly circular, some are oval, and some are in overlapping complexes. The dolomite in the reefs is exceptionally pure, containing only traces of argillaceous material

Fig. 11 - Exposures of Silurian formations

A - Racine Dolomite (Silurian) showing a reef with dipping beds in the upper third of the quarry face overlying horizontally bedded inter-reef rock. Federal quarry of the Material Service Corporation at La Grange (Berwyn Quad.).

B - Racine Dolomite (Silurian) showing a crevice, or joint, in the dipping flank beds of a reef. The crevice contained shale with Mississippian-Devonian shark's teeth. Material Service Corporation quarry at Thornton (Calumet City Quad.).

C - Kankakee Dolomite (Silurian) showing the typical thin and wavy beds overlying the massive bed that occurs at the base of the formation. Small quarry along Atchison, Topeka, and Santa Fe Railroad, 1.5 miles southwest of Brandon Bridge (Channahon Quad.).

D - The Waukesha Dolomite (Silurian), the well bedded dolomite in the upper fifth of the 75-foot quarry face. It overlies the Joliet Dolomite (Silurian), the upper half of which (darker colored) is the relatively pure massive unit with thin beds of white chert. The lower part (lighter colored) is the well bedded, slightly silty middle Joliet unit. National Stone Company quarry on the south side of Joliet (Joliet Quad.).

and rare, isolated sand grains. With a few minor exceptions, the reef rock contains no chert. The dolomite is medium gray, mottled with light or dark gray. Because it has a low iron content, it weathers gray. Most beds are conspicuously vuggy. In a few localities the vugs are partly filled with asphaltum, a solid petroleum residue that on hot days melts and oozes from the vugs on quarry faces.

The reefs are surrounded by argillaceous and silty dolomite, and lenses of green shale are locally present. In contrast to the dolomite of the reefs, the inter-reef rock is fine grained, dense, commonly cherty, light brownish gray, and weathers brown. Small reefs consisting of lenses of massive, pure dolomite occur on the slopes of the major reefs and in the interreef beds.

The larger reefs have a central area, or core, of massive to irregularly bedded dolomite (fig. 10E). The marginal areas, broader than the core in some reefs, consist of dipping beds, called flank beds (fig. 10F). The flank beds entirely surround some reefs and show the successive stages of outward growth of the reef, partly by growth of reef-building organisms on the outer slope of the reef, partly by deposition of debris eroded by waves and washed down the flank. The beds dip as much as 30 degrees, but at their outer margin they flatten and grade into argillaceous interreef types of sediments. In places the argillaceous beds continue short distances up the flanks, showing intermittent encroachment of the interreef sediments. When the reefs ceased to grow, they were entirely overlapped by the argillaceous sediments.

The lowest base of a large reef is at the top of the Joliet Formation. Other reefs start at higher positions (fig. 11A). Some extend to the top of the Racine Formation and probably extended higher before being eroded along the sub-Middle Devonian unconformity.

A large reef has been progressively exposed during development of the quarry of the Material Service (General Dynamics) Corporation at Thornton (Harvey and Calumet City Quads.). The transition from the reef core through reef flank deposits and marginal reefs (fore reefs) to interreef rocks is well exposed, and the lithology, structure, and paleontology of the reef have been described in numerous reports (Bretz, 1939; Lowenstam, 1950; Lowenstam, Willman and Swann, 1956; Willman, 1962; Ingels, 1963).

DEVONIAN SYSTEM

Rocks of Devonian age are present in the Chicago area beneath Lake Michigan, only a few miles offshore, and the entire area was probably covered by several hundred feet of Devonian rocks that were deposited in the middle and late Devonian seas. Devonian limestone overlain by black shale occurs in Indiana only a short distance east of the Illinois-Indiana state line. Black shale, probably the Grassy Creek Shale of Upper Devonian age, has been found in pockets on top of the Silurian dolomite at Elmhurst. Shale in joints in the Silurian Dolomite in the Thornton reef contains sharks' teeth that are Devonian or Mississippian in age (Bretz, 1939) (fig. 11B). The shale assigned to the Mississippian Hannibal Formation in the fault blocks of the Des Plaines Disturbance (fig. 13) may be equivalent to the Ellsworth Formation of Michigan and Northern Indiana, in which case only the uppermost part is Mississippian and the lower part is late Devonian in age (J. A. Lineback, personal communication).

MISSISSIPPIAN SYSTEM

Rocks of Mississippian age at one time probably covered the entire Chicago area, but they are now present only in the fault blocks of the Des Plaines Disturbance and are not exposed (fig. 13). In the fault blocks as much as 500 feet of shale and siltstone is assigned to the Hannibal Shale of early Mississippian (Kinderhookian) age, although, as previously noted, it may include a large proportion of late Devondivide where it connects with a northeastward-sloping valley, the Hadley Valley is still entrenched about 100 feet into the bedrock surface. It is nearly 100 feet lower than the bedrock divide along the channel of the Des Plaines Valley, which was entrenched in the bedrock surface by the Outlet River of Lake Chicago. Hadley Valley may have been formed by the overflow of a glacial lake, an ancestral Lake Chicago, which formed in the Lake Michigan Basin when the Illinoian glacier retreated or the Wisconsinan glacier first advanced. It was overridden by the Wisconsinan glaciers and partially filled with glacial deposits. Short segments were reexcavated by Spring Creek (Mokena Quad.).

GLACIAL STRATIGRAPHY

QUATERNARY SYSTEM

The Quaternary System consists of all the rocks younger than the Tertiary, including those accumulating at present. As the system contains only one series, the Pleistocene, the terms Quaternary and Pleistocene apply to the same rocks (fig. 15).

PLEISTOCENE SERIES

The Pleistocene Series includes all the unconsolidated rock formations in the Chicago area that overlie the Paleozoic bedrock. These deposits are related predominantly to the glaciers that repeatedly covered the area, but they also include deposits made since the glaciers melted — by rivers and streams, by slopewash and slumping, by sedimentation in lakes and ponds, and by the work of man.

The advancing glaciers eroded the bedrock formations, as is evident from the scratches (striations) on the bedrock surface, and the lower parts of the glaciers became loaded with rock debris of all sizes from clay and silt to cobbles and boulders. Shearing movements in the ice produced a grinding action that pulverized many rocks to small fragments and thoroughly mixed materials from many different rock formations.

When the ice melted it deposited a material called till (fig. 17A) that is an unsorted mixture of rock fragments of all sizes. The kind and size of the rocks in the till are both related to the kinds of rocks overridden by the glacier. Because the glaciers took different courses across different rock formations, they deposited tills with different compositions. Mineral and grain-size analyses, therefore, are useful in differentiating some of the tills.

As the glaciers melted, water flowing in channels on, in, and below the ice picked up rock debris and began the process of sorting it by size. When reduction in volume or velocity of the water resulted in quick deposition of the coarser materials in channels in the glacier or along its margins, much of the clay and silt remained in suspension and was carried away from the ice. The sand and gravel thus deposited is poorly sorted and has irregular and distorted bedding (fig. 17C). These ice-contact sand and gravel deposits occur in conical hills (kames), in elongate ridges (eskers), and in lenses within the till sheets.

Sand and gravel transported away from the ice by meltwater streams before it was deposited is better sorted and is called outwash. Sheet-like deposits of outwash along the front of the glaciers are called outwash plains. Outwash deposits in valleys are called valley trains. When the outwash was carried by the streams into lakes, the materials were further sorted. Near the shore, sand and gravel were deposited in beaches, bars, spits, and deltas, while clay, silt, and fine sand were deposited in the deeper water.

Water flowing from glaciers transports large quantities of silt, clay, and sand. These fine-grained materials give the meltwaters of modern glaciers a cloudy, or

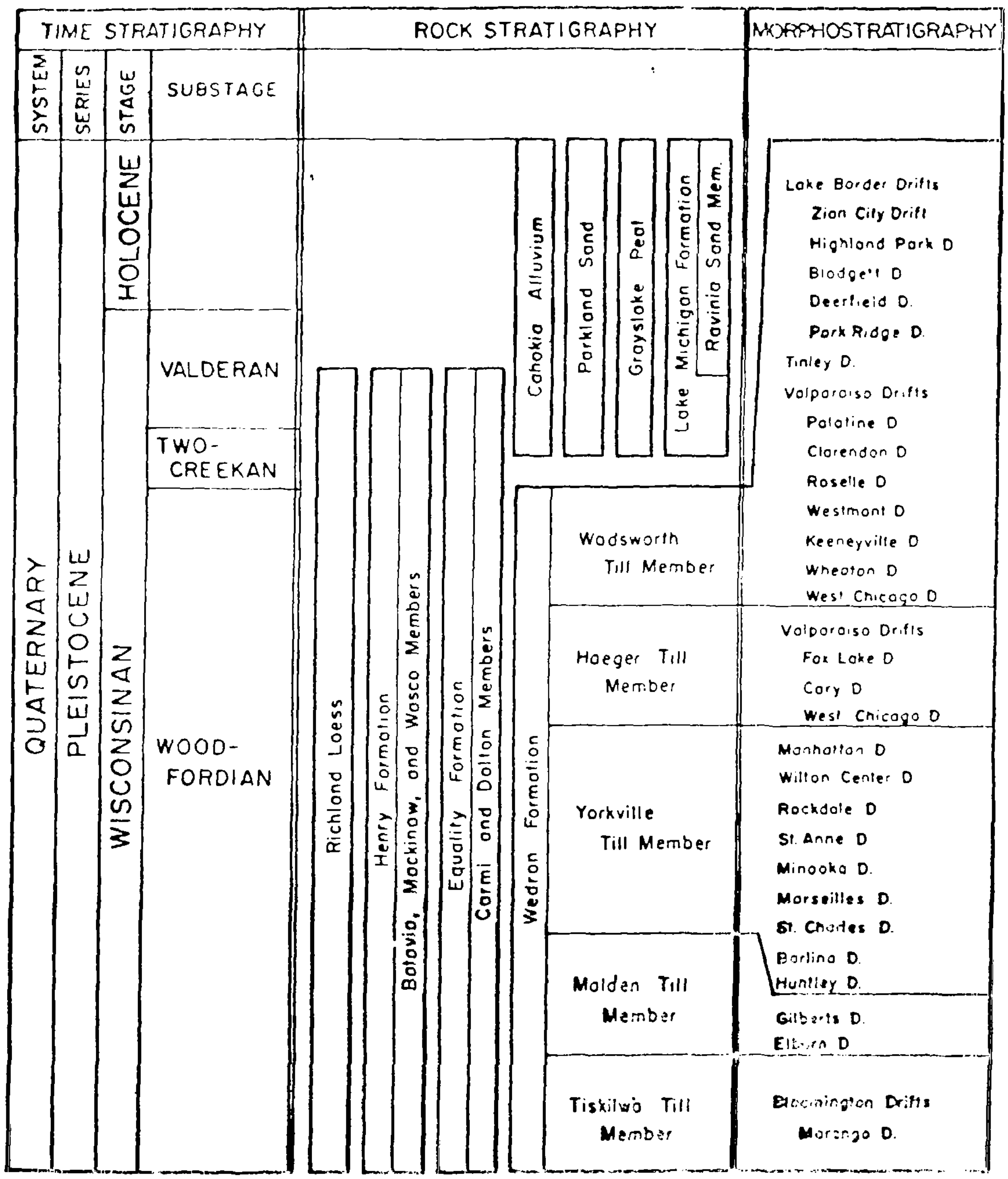

Fig. 15 - Classification of the Pleistocene rocks of the Chicago area (after Willman and Frye, 1970).

Where the Sangamon Soil was eroded by the Wisconsinan glaciers, differentiation of the Illinoian and Wisconsinan tills is difficult, but it has been accomplished in the area immediately west, partly by mineral and grain-size analyses (Frye et al., 1969).

Wisconsinan Stage

The glacial deposits in the Chicago area are almost entirely Wisconsinan in age. The Wisconsinan Stage is subdivided into five substages: (1) the Altonian, which milky, appearance. When deposited in river bottomlands and exposed to drying winds during low-water stages, such materials are subject to erosion by wind. Wind is more selective than flowing water in its sorting action. It leaves the sand behind in slow-moving dunes and carries silt and clay in clouds onto adjacent bluffs and uplands, first depositing the coarser silt and then, at greater distances, progressively thinner and finer grained silt and clay. The deposits of wind-blown silt and clay are called loess.

The stratigraphic nomenclature of the Pleistocene deposits in the Chicago area is shown on figure 15. The classification to which each unit belongs is identified by the word following the geographic name. Pleistocene nomenclature is complicated by the naming of many individual features and events, such as Lake Chicago, Calumet lake stage, Toleston beach, Glenwood spit, Chicago Outlet River, Kaneville Esker, Kankakee Flood, and many others. These are not stratigraphic units. The Glenwood spit, for example, is only one of many spits that were built into Lake Chicago. The deposits forming these spits are part of the Dolton Member of the Equality Formation in the rock-stratigraphic classification. The names of many features and events are identified in the section on glacial history.

Although the repeated fluctuations of the glaciers produced many different units, exposures of more than two or three in a single outcrop are not common. Exposures of the Barlina, Huntley, Gilberts, and Marengo Drifts in sequence along the Huntley road 2 miles west of Algonquin (Crystal Lake Quad.) is exceptional. The stratigraphic sequence of units in the drift is better determined by studying samples from drill holes (Horberg, 1953; Kempton, 1963; Hackett and Hughes, 1965; Larsen and Lund, 1965; Lund, 1965a, 1965b, 1966a, 1966b; Piskin and Bergstrom, 1967; Landon and Kempton, 1971).

As the glacial deposits immediately underlie the Modern Soil in most of the Chicago area, mapping of these deposits is of major importance in environmental geology. The surficial geology map (pl. 1) shows as many map units as it was practical to map on that scale. To bring out major changes in composition and the principal geologic features, several types of units are mapped. Most of the map units are rock-stratigraphic and morphostratigraphic units, but some show important relations, such as thin till on sand and gravel. Other map units are surfaces, such as lake plains and shorelines that have local lacustrine deposits and, also, glacial sluiceways that have local deposits of sand and gravel. The major units are shown on the glacial map (fig. 16).

The principal general reports on the Pleistocene stratigraphy of the Chicago area are by Leverett (1897); Goldthwait (1909); Trowbridge (1912); Culver (1922); Fisher (1925, 1928); and Bretz (1939, 1955). Other reports that deal in part with the Chicago area are by Leverett (1899); Ekblaw and Athy (1925); Leighton (1925); Fryxell (1927); Powers and Ekblaw (1940); Ekblaw (1959); Willman, Glass, and Frye (1963); Frye, Willman, and Black (1965); Kempton and Hackett (1968); Hackett and McComas (1969); and Willman and Frye (1970). The history of Lake Chicago has been discussed in many reports, including those by Leverett and Taylor (1915); Bretz (1939, 1951, 1955, 1964, 1966); Hough (1958, 1963, 1966); and Wayne and Zumberge (1965). The following discussion of the stratigraphy and geologic history of the Pleistocene is based largely on these and other reports.

The classifications of the Pleistocene deposits used in this report are those introduced for Illinois by Willman and Frye (1970).

Illinoian Stage

Illinoian drift 25 to 50 feet thick probably covered the Chicago area at the beginning of Wisconsinan glaciation, but it was eroded and no Illinoian drift has been definitely identified in the area. Patches of Illinoian drift may remain in protected localities, particularly in the western parts of McHenry and Kane Counties.

includes till and outwash buried by younger drift and is found mainly in the northwestern part of the area; (2) the Farmdalian, which includes local deposits of peat, organic silts, and lake deposits; (3) the Woodfordian, which includes most of the Wisconsinan till, outwash, and lake deposits in the area; (4) the Twocreekan, which includes local lake and swamp deposits buried in the Lake Chicago sediments; and (5) the Valderan, which includes lake deposits in a small part of the Lake Chicago plain and part of the youngest sand and gravel deposits in the Des Plaines and Illinois Valleys.

The time span of the substages in radiocarbon years before the present (B.P.) is as follows (Willman and Frye, 1970, fig. 14):

Valderan Substage	- 7,000 to 11,000
Twocreekan Substage	- 11,000 to 12,500
Woodfordian Substage	- 12,500 to 22,000
Farmdalian Substage	- 22,000 to 28,000
Altonian Substage	- 28,000 to 75,000

Radiocarbon dating cannot be used to determine the age of deposits older than the Wisconsinan, and generally not of those older than 50,000 radiocarbon years. Radiocarbon years are based on isotopic analyses and, although close, are not precisely equivalent to years based on rotation of the earth around the sun.

Altonian Substage

Winnebago Formation

The drift of the Winnebago Formation is the surface drift just west of the front of the Marengo Moraine, and in one locality it is only a mile west of the Chicago area (pl. 1) (Frye et al., 1969). In the northwestern part of the area, the Winnebago Formation is widely present below the Marengo and younger drifts. It is exposed in a local area too small to show on plate 1 along Big Rock Creek 3½ miles northeast of Plano on the Kane-Kendall County line (Yorkville Quad.), where two pinkish gray, silty, sandy tills are separated by a bed of silt, called the Plano Silt Member (Kempton and Hackett, 1968). The silt has been found in several borings, and peat from it has been dated at 32,600 to 41,000 radiocarbon years B. P.

In the lower parts of the bluffs, along the Des Plaines Valley from Summit to Romeo (3 miles west of Lemont) and along the Sag Channel from Worth to Sag Bridge, many exposures of yellow, silty till are associated with lenticular bodies of poorly sorted gravel and sand and cross-bedded sand and silt. These deposits are informally called the Lemont drift (Bretz, 1955; Horberg and Potter, 1955; Willman and Frye, 1970). They may be part of the Winnebago Formation. Their age is uncertain and they have been variously correlated with Illinoian, Altonian, and Woodfordian deposits. They appear to have been eroded and weathered before they were covered by Valparaiso Drift.

Farmdalian Substage

Robein Silt

Peat and organic silt deposits overlying the Winnebago Formation and underlying the Wedron Formation are assigned to the Robein Silt Formation. They were previously called Farmdale Silt. They have been encountered in borings along the Northwest Toll Road and elsewhere in the northwestern part of the area (Kempton, 1963; Kempton and Hackett, 1968). Dates of 23,000 to 26,000 radiocarbon years B.P. were obtained from the peat.

A waterlaid silt overlain by pink till of the Tiskilwa Member is exposed by a roadcut through the Cryder Lake beach escarpment 1 mile north of Morris (Morris

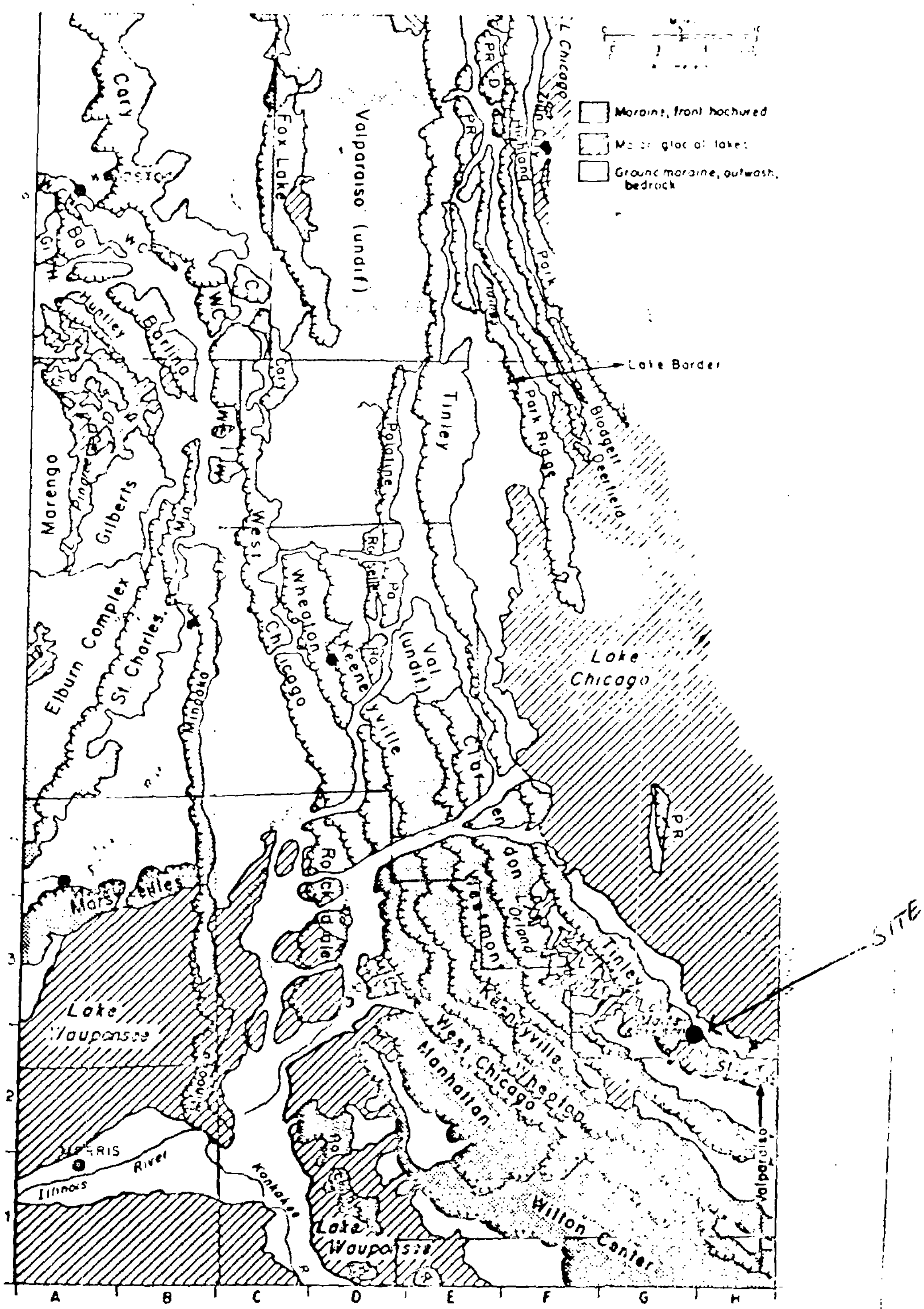

Fig. 16 - Major glacial features of the Chicago area.

Ground Water

The water supplies of the Chicago area come largely from Lake Michigan and from wells that tap ground-water resources. The smaller lakes in the area are a source of water for some communities. Artificial lakes provide limited quantities of water for local use. The rivers and streams supply little water suitable for uses other than cooling in power plants. A limited amount of water is diverted from Lake Michigan to maintain flow through the Chicago Sanitary and Ship Canal.

The ground-water resources are in four major water-yielding units, called aquifers: (1) sand and gravel beds in the glacial drift; (2) the Shallow Dolomite Aquifer, mainly the Silurian dolomite; (3) the Cambrian-Ordovician Aquifer, in which the Ironton-Galesville and Glenwood-St. Peter Sandstones are the most productive units; and (4) the Mt. Simon Aquifer, which consists of the Mt. Simon Sandstone and the basal sandstone of the Eau Claire Formation (Suter et al., 1959).

The shallow aquifers are connected hydrologically and are recharged directly by seepage from precipitation. They are separated by the relatively impervious Maquoketa Group Shale from the Cambrian-Ordovician Aquifer. The Cambrian-Ordovician Aquifer rises westward and it is recharged at the surface or through glacial deposits west of the outcrop area of the Maquoketa Group Shale along the western side of the Chicago area (fig. 9). The Cambrian-Ordovician Aquifer is separated from the Mt. Simon Aquifer by the shaly and silty beds of the Eau Claire Formation that prevent flow between the aquifers. The Mt. Simon Aquifer has a higher artesian pressure than the other aquifers, but the water quality in the eastern part of the area is not acceptable for many uses. It is recharged largely from the outcrop region of Cambrian rocks in central southern Wisconsin (fig. 1).

The Cambrian-Ordovician Aquifer has been the most highly developed bedrock aquifer. Artesian pressure in the aquifer caused the first deep well drilled in Chicago to flow with a head 80 feet above the surface, but by 1959 the water surface had declined as much as 660 feet in a cone-shaped region around the area of heaviest pumping. On the other hand, about 60 percent of the total pumpage in the area is from the two shallow aquifers, and in them there is no widespread decline in water levels.

The geology, hydrology, and resources of ground water in the Chicago area have been discussed in detail by Suter et al. (1959) and Zeizel et al. (1962).

ENGINEERING GEOLOGY

The design of buildings, roads, dams, bridges, and subways — in fact, of all kinds of structures — is dependent on the properties and variations of the geological formations on or in which they are built. Specific conditions at each site must be evaluated for the particular structure being planned. The engineering geologist may employ test drilling, rock core and soil sample studies, and in some instances geophysical logging and laboratory testing, to evaluate the geologic conditions that must be considered in design and construction.

Major engineering problems in the Chicago area have included the design of foundations for skyscrapers, most of which require excavation through 50 feet or more of glacial deposits (largely till but including water-bearing sands and boulder accumulations) to an uneven bedrock surface. Large buildings in areas of deeper drift are placed on piling, generally driven to bedrock. Glacial till provides adequate foundations for smaller buildings and most houses.

Construction of the Chicago subway involved many problems concerned with variations in the properties of the glacial drift (Peck and Reed, 1954). Similar problems are involved in highway and bridge design and in the construction of dams (W. C. Smith, 1968, 1969). Study of the variations in the glacial drift has been important in constructing foundations for the 200 BEV accelerator at the Na-